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ABSTRACT

This guide contains basic information to meet specific standards for pesticide applicators. Characteristics, life cycles and habits of pests such as roaches, beetles, flies, ants and rodents are discussed. Additionally, pest control measures, especially by application of aerosols, dusts, baits, fumigants or vapors, is presented. (CS)

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APPLY PESTICIDES CORRECTLY
A GUIDE FOR COMMERCIAL APPLICATORS

FOOD PROCESSING PEST CONTROL

U S DEPARTMENT OF HEALTH, EDUCATION & WELFARE
NATIONAL INSTITUTE OF EDUCATION

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Many representatives of the food processing industry and food commodity associations reviewed and commented on the guide.

PREFACE

Federal regulations establish general and specific standards that you must meet before you can use certain pesticides. Your State will provide material which you may study to help you meet the *general* standards.

This guide contains basic information to help you meet the *specific* standards for pesticide applicators in the food and feed industries. Because this guide was prepared to cover the entire nation, some information important to your State may not be included. The State agency in charge of your training can provide the other materials you should study.

This guide will give you information about:
- characteristics of common pests,
- their life cycles and habits, and
- how to control them.

INTRODUCTION

The control of pests in food plants (food manufacturing, processing, and warehousing) requires a high degree of professionalism combined with experience and knowledge.

- Food plants must continually employ pest management programs.
- These programs must be directed against pests in the immediate area, and against pests that may be introduced from incoming materials.
- These programs must respond to daily needs and be flexible to meet emergency pest control situations.
- Without good pest management, contaminated products may result. Contamination can cause serious health, financial, legal, and aesthetic problems.

PESTS

A variety of pests are found in food manufacturing plants. The type of pest you will find depends on both the geographic location of the plant and the type of food being processed.

Pests may damage, destroy, or contaminate processed foods. They must be controlled to protect the quality of the product. The presence or evidence of pests may result in seizure of products or other actions by Federal or State agencies.

INSECTS

Cockroaches

Cockroaches contaminate food with their droppings, with their bodies, and with bacteria they carry. They vary somewhat in appearance and habits, but in general:

- All cockroaches have chewing mouthparts.
- They seek cover in the daytime or when disturbed at night.
- All are flat, brownish or dark, and fast-running.

The stages in the life cycle of a cockroach are:

- the egg, enclosed in a capsule which contains several eggs,
- several stages of nymphs, which look like the adults but are smaller and have no wings, and
- the adult.

AMERICAN COCKROACH:

- Adults have wings covering the entire abdomen.
- Reddish-brown.
- Adults 1 to 1½ inches long.
- Found in dark, moist areas and may live in sewers.

GERMAN COCKROACH:

- Adults have wings covering entire abdomen.
- Tan with two dark stripes running lengthwise on the area just behind the head.
- Often occur in large numbers.
- Will eat almost any food consumed by man.
- Adults 1 to 1½ inches long.
- More active than other cockroaches.

ORIENTAL COCKROACH:

- Female has small wings; male's wings cover about ¾ of the abdomen.
- Shiny black, or very dark brown.
- About 1 inch long as an adult.
- Often lives in sewers and enters buildings through drains.

German Cockroach

American Cockroach Oriental Cockroach

Stored Product Pests

Beetles are important pests of stored food. Usually both the larva and the adult will feed on foodstuffs. Under ideal conditions they can have six or more generations per year and quickly become a serious problem. Adults may have a pair of thin wings covered by a pair of thick, hard wings.

The stages in the life cycle of the beetle are:

- egg,
- larva,
- pupa, and
- adult.

RICE WEEVIL—GRANARY WEEVIL:

- About ⅛ inch long; dark brown.
- Pronounced snouts.
- Larvae are small, white, legless grubs that feed and develop inside individual kernels of grain.
- May attack grain prior to harvest and in storage.
- Rice weevil can fly; granary weevil cannot fly.

Granary Weevil Rice Weevil

LESSER GRAIN BORER:

- Shiny dark brown or black beetle.
- Small and slender.
- Head turned downward; very strong mouthparts which can cut through wood.
- Adult is a strong flier.
- Larvae feed on flour, grain dust, or broken or whole grain.

DRUGSTORE BEETLE—CIGARETTE BEETLE:

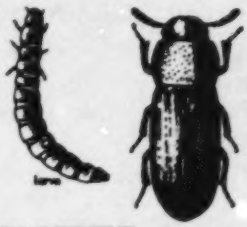
- Small, reddish-brown adults, usually less than ⅛ inch long.
- Head on adult bent down and not visible from above.
- Feed on dried plant and animal material.
- Cigarette beetle can fly; drugstore beetle seldom flies.
- Wing covers lined on drugstore beetle; smooth on cigarette beetle.

Cigarette Beetle

Drugstore Beetle

CONFUSED FLOUR BEETLE—RED FLOUR BEETLE:

- Elongated, flat adults, about ⅛ inch long.
- Shiny, reddish-brown.
- Feed on stored foods such as flour, cereal, nuts, and spices.
- Feed by scraping the surface of foods or eating finely ground material.
- Red flour beetle is a strong flier; confused flour beetle cannot fly.
- The three segments at the tip of the red flour beetle's antennae are enlarged. The antenna segments of the confused flour beetle enlarge gradually toward the tip.



Red Flour Beetle

SAWTOOTHED GRAIN BEETLE—MERCHANT GRAIN BEETLE:

- Elongated, flat adults, about ⅛ inch long.
- Dark brown.
- Adults have sawtooth-like projections on sides of area just behind the head.
- Do not fly.
- Feed on almost all dried foods.

Saw-Toothed Grain Beetle

DERMESTID BEETLES:

- Oval-shaped beetles which feed on waste grain or flour.
- Natural scavengers.
- Several species.
- Larvae are tapered, with head at the large end.
- Prominent bristles or hair often found at pointed end of larva.
- Larvae feed on dry grain dust, waste matter, or flour.

Khapra Beetle Adult

Khapra Beetle Larva

Moths cause damage by:

- eating food,
- contaminating food to the point where it cannot be consumed by humans, and
- webbing food with so much silk that mill machinery may be clogged. Large populations may lead to microorganism problems.

The stages in the life cycle of the moths are:

- egg,
- larva,
- pupa, and
- adult.

ANGOUMOIS GRAIN MOTH:

- Adults have four wings; about ½ inch wingspread.
- Forewings are pale yellow. Hind wings are gray and pointed.
- Larvae develop within whole kernels of grain.
- May attack grain before harvest as well as in storage.
- Pupa found inside grain.
- Six to seven generations per year.
- When they emerge, they leave a round flap over the hole in the grain.

Angoumois Grain Moth

INDIAN MEAL MOTH:

- Adults have four wings, with a wingspread of about ½ inch.
- Forewings have a coppery color on the outer two-thirds and whitish gray near the body.
- Larvae spin large amounts of silk in and over food.
- Larvae may leave food and crawl over adjacent surfaces.
- Five to six generations per year.
- Prefers flour but feeds on many raw and processed dry foods.

Indian Meal Moth

MEDITERRANEAN FLOUR MOTH:

- Adults have four wings, with a wingspread of about ¾ inch.
- Front wings are gray with dark wavy lines.
- Adults rest with head and thorax held high.
- Larvae feed on surface of food, and spin large amounts of silk in and over it.
- Three to four generations per year.
- Larvae leave feeding area to pupate.
- Prefers flour but infests wheat, bran, nuts, chocolate, seed, beans, and dried fruits.

Mediterranean Flour Moth

WAREHOUSE MOTH:

- Adult's forewings are gray.
- They fly in a series of quick darts.
- Habits similar to the Mediterranean Flour Moth.
- Larvae striped with a series of brown or purple dots.

Domestic Flies

Most flies have one pair of wings as adults. The larvae are called maggots and have the head at the small pointed end of the body. Larvae have no legs.

The life cycle of the fly includes:

- egg,
- larva,
- pupa, and
- adult.

BLUE BLOW FLY:

- Area behind the head gray with stripes. Abdomen shiny blue.
- Slightly larger than housefly.
- Common during early spring.
- Life cycle is 2–3 weeks.
- Attracted to decaying flesh.

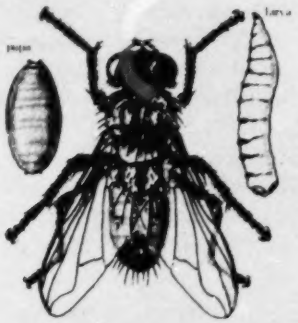
GREEN BLOW FLY:

- Body shiny green or copper.
- Slightly larger than housefly.
- Garbage is common breeding area.
- Often comes from nearby residential areas or farms.
- Life cycle is 9–18 days.
- Common during summer months.

HOUSEFLY:

- Adults dull gray with four stripes on area behind the head.
- About ¼ inch long as adult.
- Most abundant in fall, but may be found throughout the year.
- Larvae occur in animal waste or rotting fruits and vegetables.
- Life cycle is 1–6 weeks.

House Fly



FRUIT FLY (VINEGAR FLY):

- Adults about ⅛ inch long and yellowish brown.
- Attracted to sour or pungent odors.
- Adults often found around overripe fruit or vegetables.
- Life cycle is 8–11 days.
- Eggs often laid on cracks in tomatoes and similar foods.

Occasional Pests

ANTS:

- Only adults are normally seen.
- Eat many foods but prefer sweets and grease.
- Most species have winged stage once a year.
- Most come in from outside, but a few species nest in walls.

Ant

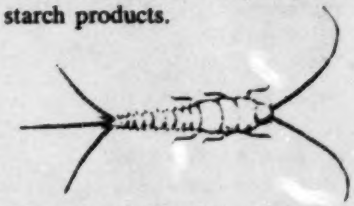
The stages in the life cycle of an ant are:

- egg,
- larva,
- pupa, and
- adult.

BRISTLETAILS (SILVERFISH, FIREBRATS):

- Gray, silver, or brownish adults, about ½ inch long.
- Young resemble adults but are sm[illegible]
- Silverfish like high humidity; firebrats prefer low humidity and high temperature.
- Can live a year or more without food.
- Often found in warehouses, where they may damage paper and starch products.

Bristle Tail



The stages in the life cycle of silverfish and firebrats are:

- the egg,
- nymphs, and
- adult, which continues to molt throughout its life span.

BOOKLICE (PSOCIDS):

- Very small ($\frac{1}{20}$–$\frac{1}{10}$ inch).
- Young resemble adults.
- Normally live in moist areas and feed on fungi.
- May be carried into food manufacturing plants on infested pallets and cardboard slipsheets.
- Have been found in newly manufactured empty containers.

Booklouse

Life cycle takes a little over a month. The stages are:

- egg,
- nymph, and
- adult.

CRICKETS:

- Winged adults are attracted to lights in summertime.
- May stray into food manufacturing plants and contaminate food.
- May eat holes in paper, cloth, or rubber.
- Large hind legs adapted for jumping.

Stages in the life cycle are:

- egg,
- nymphs, and
- adult.

SPIDERS AND MITES

- Spiders are usually just a nuisance, but the black widow and brown recluse are poisonous.
- Spiders are more commonly found in warehouses than in production areas.
- Webs, bodies, and excretions of spiders can be a nuisance.
- Presence of spiders may indicate an insect infestation problem.
- Mites are extremely small.
- Some mites contaminate food.
- A heavy infestation of mites produces a pronounced pungent odor.
- Mites may cause skin rash to humans and digestive disturbance if eaten.

CENTIPEDES

- Has many legs—one pair per segment.
- Beneficial and eats insects, but may contaminate food.
- Large populations are associated with moisture and decaying vegetable matter.
- May enter from outside.
- May frighten some workers, but not poisonous.

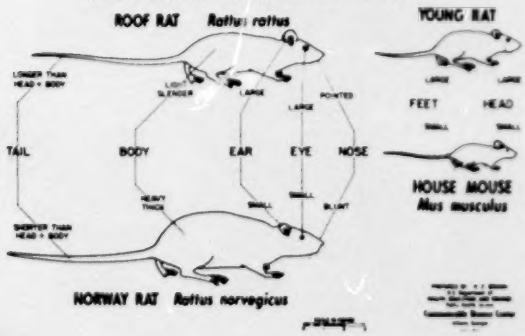
RODENTS

- Contaminate and destroy food products.
- Damage equipment, structures, and other nonedible items.
- May carry diseases and ectoparasites.
- Can cause fires.
- Have the ability to coexist with man.

The three most common kinds are:

- Norway, brown, or common rat,
- roof or black rat, and
- house mouse.

Field Identification of Domestic Rodents



The Norway rat prefers to live in underground burrows, but can climb readily. The roof rat prefers to live in upper portions of a building, but may use burrows. The house mouse lives in any convenient protected space inside or outside.

BIRDS

Only three species of birds—English sparrows, pigeons, and starlings—are normally considered pests around food manufacturing plants. They are primarily objectionable because:

- Their feathers and droppings can contaminate food.
- They may spread diseases.
- They may ruin roofs and gutters and deface buildings with their droppings.
- They sometimes carry mites which can bite man.

PEST CONTROL

INSECTS

Cockroaches

Continual removal of food and water sources and destruction of breeding places are essential in obtaining satisfactory cockroach control. Apply insecticides as crack and crevice or spot treatments to places where the insects hide. Follow label directions for commercial food handling areas.

Common hideouts are behind and beneath built-in equipment, beneath trash, in floor drains, sewers, and in cracks and crevices in concrete, brick, or block walls. Sprays are usually preferred to dusts because they are easier to apply and the residue is not visible. Dusts, however, can sometimes be blown into places difficult to reach with spray.

Use ULV (ultra low volume) concentrates and aerosol applications of contact sprays and flushing agents to supplement residual sprays and dusts. Use them alone where the label prohibits use of residuals.

Stored Product Pests

To eliminate infestations, find and destroy infested materials and treat the area where they are stored. Some infested materials can be treated with cold or heat or fumigated. Thorough cleaning is essential to remove spilled food to prevent reinfestation.

Domestic Flies

Successful fly control must include a combination of sanitation measures, mechanical lures (electric grids), physical barriers (screens or air curtains), and insecticides. The plant and surrounding area should be kept free of garbage, manure, and decaying plant or animal matter. Continual removal of solid and liquid process wastes is essential to prevent the formation of breeding sites. Control adults by spraying resting places with the use of aerosols or ULV concentrates. Baits can be used to treat breeding sites.

Ants

Control ants by direct treatment of their nests. Dusts can be used on outdoor-nesting ants. For control of indoor-nesting ants, use formulations that will not move far from the spray site. Follow label directions. Sprays or granular insecticides can also be used on the nests and surrounding area. If you cannot locate the nest site, apply insecticides where the ants gain entry or hide—along foundation walls, at doorways, windowsills, baseboards, or behind or beneath equipment.

Bristletails

Directed sprays applied to cracks and crevices that serve as hiding and resting places are most frequently used for control; dusts and baits may also be used as well as aerosols and ULV concentrates.

Booklice

Remove moisture and food sources. Directed sprays and aerosols are effective in control.

Crickets

Remove trash piles and tall weeds. If a dump or similar area is a breeding place, cover it with 6 inches of soil or ashes. Outdoor sprays give only temporary control. Inside, spray residual pesticide in areas where crickets have been seen.

SPIDERS AND MITES

Control insects that serve as food, and remove webs. Direct pesticide sprays or dusts at hiding areas.

CENTIPEDES

Remove sources of moisture and decaying vegetable matter. Use wettable powders or emulsifiable concentrates of residual pesticide in a 2- to 3-foot strip around the outside of the building. Treat suspected breeding sites by applying the pesticide with enough water to carry it down to where the pests live.

RODENTS

A rat or mouse control program is based on knowing:

- where they live, feed, and travel, and
- the extent of the infestation.

You must eliminate shelter, food, and water. Close all entrances the rats or mice use to come and go from buildings. These preventive measures are the key to successful control. To prevent rodent migration, it is best to poison or trap before making environmental changes.

The two categories of rodenticides are:

- multiple-dose anticoagulants, and
- single-dose poisons.

Each rodenticide has special characteristics, uses, and hazards. Some are highly toxic to humans and pets. Mix, handle, and apply them according to label directions.

Place bait deep into burrows or use bait stations. Keep them away from people and desirable animals. Dispose of excess baits and dead animal carcasses at frequent intervals.

Mice will eagerly sample new food. Rats, however, usually approach new food with caution. If it tastes bad or makes them sick, they will not eat it again. This is "bait shyness". When using bait for control, use a bait that is fresh and identical to the food the rats are using. If you use a different bait base, prebait in the area for a few nights before using a toxic bait. Alternate anticoagulants with single-dose poisons to reduce possibility of the development of resistance. Certain baits may attract insects and should be replaced often.

Rats require water to drink. Mice may get water from the food they eat. If all water sources can be eliminated, liquid baits are very effective for rats but only moderately so for mice.

Both rats and mice prefer to run next to walls or other surfaces. Place traps and baits in these runways. Traps may be used with bait, or the trigger

device may be expanded and used without bait. Rats approach new objects cautiously.

The mouse investigates any new object or change in its territory, so changing placement of baits or traps may improve control. Each house mouse establishes a territory which may not extend more than 10 feet from the nest. For this reason, baits and traps should be placed no more than 10 to 20 feet apart.

Be aware of nearby environmental disruptions that may cause rodents to enter buildings.

BIRDS

Sanitation is the first step in control. Remove food, water, and habitat. Control methods include building out, removing food, and using repellents, traps, or avicides.

Building out involves using new construction features or modifying existing features so that birds cannot roost or nest.

Repellents include various devices or substances installed in potential bird roosting and nesting areas. They include revolving lights, noise makers (distress calls), charged wires, and repellent glues or jellies.

Traps are often used successfully in pigeon control, especially when prebaited for a few days. Release any birds that are protected by law from such control methods.

Population reduction includes shooting (where permissible) and the use of avicides. Chemical control is probably the most effective method. Follow label directions closely. Know your city, county, State, and Federal regulations.

PEST TREATMENT AREAS IN FOOD PLANTS

Food plants have five areas of activity where pests must be controlled:

- receiving and storage area for incoming materials,
- processing area,
- packaging area,
- finished product warehouse and shipping area, and
- grounds—the building exterior and the area around the plant.

Both chemical and nonchemical controls are important in these areas. Nonchemical controls include both preventive maintenance and mechanical and physical measures.

Pests may enter the plant in two ways:

- by slipping by the outside control programs, and
- by coming in with ingredients or materials.

Some nonchemical control methods that apply to all areas inside a plant are:

- Rodent-proofing and bird-proofing doors, walls, windows, and roofs.
- Screening all windows that can be opened.
- Eliminating cracks, crevices, and other places where pests may hide.
- Whenever possible, locating equipment off the floor and away from walls or sealing it to walls and floors.
- Keeping the building clean and free of litter.
- Keeping the inside and outside of all equipment clean.
- Using light traps for insects.

INCOMING INGREDIENTS AND MATERIAL STORAGE AREAS

Nonchemical Controls

- Visually inspect all vehicles, ingredients, and materials to insure that pests are not brought into storage areas.
- Store ingredients and materials far enough away from walls to permit access for inspection.
- Use FIFO (first in-first out) rotation of incoming materials.
- Use traps or other methods for rodents.
- Use air curtains at dock and pedestrian doors to keep insects out.
- Use mechanical repellents for birds.

Chemical Controls

INSECTS:

- Space treatment with nonresiduals.
- Crack and crevice treatment with residuals.
- Spot treatments with residuals.
- Periodic general treatment.
- Treatment of raw bulk commodities with fumigants and sprays on receipt and during storage where applicable.

RODENTS:
- Bait stations.

PROCESSING AND PACKAGING AREAS

Nonchemical Controls

- Place rodent traps near doors if situation warrants.

Chemical Controls

INSECTS:
- Space treatment with nonresiduals.
- Spot treatment with nonresiduals.
- Crack and crevice treatment with residuals.
- Contact treatment with nonresiduals.
- Periodic general treatments.

FINISHED PRODUCTS WAREHOUSE AND SHIPPING AREAS

Use the same pest control methods in the finished products warehouse as in the materials receipt and storage area.

Vehicle inspection is essential to prevent the finished products from being placed in a pest-contaminated carrier. Vehicle inspection is difficult, particularly for boxcars and trucks with false walls or endliners. If vehicles are dirty or infested, do not use them.

Chemical Controls in Vehicles

Before loading, consider:
- space treatment, or
- crack and crevice treatment.

After loading, use:
- general treatment—usually a solid fumigant—for in-transit control.

GROUNDS

Nonchemical Control

- Eliminate all exposed dirt surfaces by paving all roadways or parking areas and maintaining well-kept lawns. This will reduce contamination from dirt, microbes, and other airborne particles.
- Provide good drainage to help keep the area clean and dry.
- Place outside lighting away from buildings and focus the lights toward buildings. This helps keep night-flying insects away from doors and windows.
- Screen potential bird roosting areas.
- Store equipment so that it does not become a place for pests to hide.
- Remove all litter, weeds, and grass clippings.
- Eliminate any waste that may accumulate near exhaust systems.
- Use rodent, insect, and bird traps as necessary.

Chemical Control

- Baits for rodents.
- Baits, fogs, and sprays for insects.
- Chemical repellents or avicides for birds.

PESTICIDES

AEROSOLS

ADVANTAGES:
- Excellent for flying or exposed insect pests.
- Disperse well if used correctly.
- Convenient and easy to store.
- Usually leave little surface deposit.
- Store well during normal use period.
- Available for hand operations or can be installed as a timed release system.

LIMITATIONS:
- No lasting protection.
- Good only for exposed pests.
- Hazardous if container is punctured or overheated.
- Usually cannot be used during food processing or when people are present.

LIQUIDS

ADVANTAGES:
- Usually provide a deposit on surface.
- Can be easily directed onto surface for treatment.
- Easy to store, transport, and handle.
- Adaptable for use in many kinds of equipment.

LIMITATIONS:
- May be hazardous to use around electrical outlets (water or oil sprays).

- May damage or stain wallpaper, varnish, and many fabrics (water or oil sprays).
- May leave unsightly residue (wettable powders).
- Require agitation during application (wettable powders and emulsions).
- May be hazardous around open flames (oil sprays).
- May damage or etch asphalt, plastic tile, or rubber products (oil sprays).
- May make floors slippery (oil sprays).
- May damage living plants (oil sprays).

DUSTS

ADVANTAGES:
- Excellent for crack and crevice treatments.
- May be purchased ready-to-use.
- Usually require only simple and lightweight application equipment.
- Safe for use around electrical equipment.

LIMITATIONS:
- Drift easily.
- Easily dislodged from treated surface (should not be applied on equipment or above food-contact surfaces).
- Generally bulky to store.

GRANULES

ADVANTAGES:
- Ready-to-use.
- Do not drift.

LIMITATIONS:
- Can be used only on fairly level surfaces.
- May be tempting to nontarget animals.

BAITS

ADVANTAGES:
- Can often control specific pests.
- Easily distributed.
- Easily monitored and recovered.
- Used in small amounts.

LIMITATIONS:
- Can be dangerous to nontarget animals.
- Often not as attractive as natural food supply.
- Rodents must feed for 5 to 15 days on an anticoagulant rodenticide before it is lethal.
- Rodents feeding on poison baits may die anywhere and go undetected, causing sanitation problems.

FUMIGANTS

Fumigants penetrate cracks, crevices, and the commodity being treated. They must reach the target pests as gases to be effective. As soon as a fumigant diffuses from the target area, reinfestation can occur. Fumigants must be applied in enclosed areas.

Types of Fumigation

Types of fumigation are:
- general fumigation (buildings and their contents),
- spot fumigation (machinery, facilities, bulk commodities),
- tarpaulin or chamber fumigation (packaged commodities), and
- vehicle or in-transit fumigation (trucks, ships, and railway boxcars).

Selection of Fumigants

When choosing a fumigant, consider:
- toxicity to the target pest,
- volatility and ability to penetrate,
- corrosive, flammability, and explosive potential,
- warning properties and detection methods,
- effect on seed germination and finished product quality,
- residue tolerances,
- availability,
- ease of application, and
- cost.

Several factors can change the efficiency of fumigants. Consider these when selecting a formulation and dosage:

Temperature—The fumigant may not kill the pests if the product or space being fumigated is below 10° C (50° F) or above 46° C (115° F).

Moisture—As the moisture content of a commodity increases, it becomes more difficult for a fumigant to penetrate it. This also increases the potential for residues exceeding legal tolerances. Adequate moisture is required for the generation of some fumigants.

Pests—Susceptibility to fumigants depends on species, habitat, and stage of development. During some stages of their life cycle, for example, many insects are protected by the product they infest.

Structure—Consider the condition of the structure, the type of construction, and the product it contains.

A wooden structure, even when sealed well, will not retain fumigants as well as metal, plastic, masonry, or concrete. Fumigation in vacuum chambers allows increased efficiency.

Method of Application—Fumigants are widely used because they can be applied in many ways. Fumigation techniques include:

- Applying solid or liquid formulations to streams of bulk grain.
- Applying liquid formulations to the surface of grain. The vapors flow down through the grain either by gravity or by forced distribution with bin aeration systems.
- Piping liquid or solid formulations into a grain mass to eliminate local infestations.
- Using spot fumigation in structures or in machinery or products.

Preparing for Fumigation

Understand fully the facility and commodity to be fumigated, including the:

- design of the structure, as well as adjacent and connecting structures both above and below ground,
- persons or animals expected to be at or near the area to be fumigated,
- the commodity, its history and condition (previous fumigation, temperature, moisture),
- availability of emergency shutoff stations for electricity, water, and gas,
- location of nearest telephone, and numbers for fire or police departments, hospitals, and physician.

Select a suitable fumigant.

Understand label directions, warnings, and antidotes.

You may need to notify local medical, fire, and police authorities and other security personnel about:

- chemicals to be used,
- proposed date and time of use,
- type of gas masks required,
- fire hazard rating, and
- name and phone number of person to contact in event of emergency.

Have alternate application and protective equipment and replacement parts available. Display warning signs near points of entry and provide for security of buildings. Have necessary first aid equipment available. Before treatment is started, develop plans to ventilate the area when the treatment period is over.

Application

Always assign two persons to each fumigation. Everyone involved in the fumigation should know first aid and other emergency procedures, including personal decontamination.

Follow label directions exactly when applying a fumigant. Consider prevailing winds and other pertinent weather factors such as temperature and humidity. Apply fumigants from outside the exposed areas wherever possible.

Inspect all valves, gauges, and in-plant piping before using built-in fumigation system where fumigant source may be either inside or outside the area being treated.

Return to the storage area all unused chemicals in clearly labeled, original containers. Dispose of empty containers correctly.

Provide watchmen, when required. Entrances should be secured by guards or locks.

Report to company-retained physician or to designated personnel, indications of illness or physical discomfort, no matter how minor they seem. These symptoms and signs may include: dizziness, nausea, headaches, and lack of coordination.

Do not consume alcohol for 24 hours before or after a fumigation.

After Application

Before reentry, use a suitable gas detector, as indicated on the label, to determine fumigant concentration. Do not depend on odors. Some fumigant gases are odorless. Wear correct respiratory equipment.

Turn on all ventilating or aerating fans.

Check for gas concentrations in areas that are expected to aerate slowly.

Remove warning signs when the gas concentration is within safe limits for human exposure.

Remove and dispose of packaging and waste products of solid fumigants.

Fumigants are useful but have specific advantages and limitations.

ADVANTAGES:
- Toxic to many pests.
- Can be applied by various methods.
- Easy to apply without disturbing the commodity.
- Penetrate structures, commodities, and equipment.
- Readily available and economical.

DISADVANTAGES:
- Toxic to humans.
- Require trained applicators.
- Target area or commodity must be enclosed.
- May injure seed germination.
- Temperature requirements may be hard to meet, especially in northern climates.

VAPORS

Vapors are volatilized by supplementary heat or by inherent high vapor pressure to produce a gas. They are usually dispersed from impregnated resin strips, or vaporizers.

ADVANTAGES:
- Easy to apply and safe to handle.
- Can be used where fumigant tolerances may be exceeded.
- Sealed building not as essential as for fumigants.
- Effective against flying insects such as moths and flies.

DISADVANTAGES:
- Will not penetrate commodities in concentrations lethal to target pests.
- Resin strips cannot be used in plant areas where food is exposed.

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